NEW YORK STATE DEPARTMENT OF TRANSPORTATION MATERIALS BUREAU ALBANY, NY 12232	MATERIALS METHOD - NY 9.5
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PROJECT TESTING PROCEDURES FOR HIGH DENSITY CONCRETE BRIDGE DECK OVERLAYS

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SCOPE

This testing procedure describes methods and frequencies for sampling and testing High Density Concrete on bridge deck overlay projects.

There are primarily two types of testing required on these projects. They are:

A. Slump, Air Content and Casting Test Cylinders

B. In-Place Nuclear Density Testing

A. Slump, Air Content and Casting Test Cylinders

TEST PROCEDURES

These tests shall be conducted as described in NYSDOT Materials Method 9.2 Field Inspection of Portland Cement Concrete with the following additional requirements:

Slump Test. This test must be delayed 3 to 5 minutes after sampling. Throughout the waiting period the concrete should be covered with damp burlap to prevent evaporation of water from the mix. At the end of the waiting period the sample should be re-mixed. This delay in testing is a phenomena of the concrete-mobile mixing action.

Air Content Test. The air content should be determined by the Pressure Method described in Appendix C of Materials Method 9.2.

In order to achieve proper air content, the air pot should be filled, consolidated and struck off within three (3) minutes of sampling.

Casting Test Cylinders. In order to achieve thorough consolidation of cylinders, the cylinders should be fabricated within three (3) minutes of sampling.

The age of cylinder testing shall be determined by the Engineer. Ideally the age should be four (4) days, which is the minimum curing period to opening to traffic.

TESTING FREQUENCY

Control Series

Slump and Air. Slump and air tests shall be conducted each time the mobile units are reloaded with materials and prior to project concrete production. Additional air tests should be conducted whenever air entrainer flowmeter settings are changed.

Cylinder Series

Slump, Air and Cylinders. This test series should be run once per day per mobile unit. The cylinders shall be cast in pairs.

DOCUMENTATION

The High Density Concrete Project Testing Report shown in Appendix C should be used for recording slump, air and cylinders. Additional information to be recorded should include: time of test, mobile mixer I.D. number, flowmeter settings (water and air entrainer). Cylinders should also be documented on the Concrete Cylinder Report BR300a. The cylinder purpose should be listed as other on the BR300a.

B. In-Place Nuclear Density Testing

Density of the High Density concrete overlay shall be monitored using a nuclear gauge in the 2 inch direct transmission mode. This density is referenced to the project theoretical density.

EQUIPMENT

Nuclear Gauge - Shall be direct transmission nuclear density gauge, commercially available and complete with radioactive source, detector systems and scaler. The manufacturer's calibration data shall accompany each gauge.

Reference Standard - A substance of uniform, unchanging density shall be provided with each gauge for the purpose of performing daily, monthly or periodic calibration checks.

Guide Plate and Miscellaneous Hand Tools

LICENSING AND CERTIFICATION

New York State requires that the owner of a nuclear gauge be licensed by the State Labor Department. The license requires that the operator of the device be certified and that the device be maintained and stored in a safe manner.

Operators certification is accomplished by successfully completing training in the theory and use of a nuclear gauge. This training and certification is usually conducted by the manufacturer under the auspices of the State Labor Department.

TEST PRELIMINARIES

Density Gauge Qualification:

Gauge qualification is required every 30 days or whenever the density reading is suspect. This qualification checks both the stability and drift of the gauge.

Gauge qualification procedures are detailed in Appendix A of this report.

Daily Standard Count:

Daily standard counts are taken for two reasons:

1. Standard counts are required for computing density of concrete.

2. Daily standard counts are required for checking gauge stability and drift. If excessive variations occur in daily standard counts gauge instability should be suspect and complete stability test as described in Appendix A should be conducted.

Daily standard count test procedures and allowed variations are detailed in Appendix B of this report.

TEST PROCEDURE

1. Prior to concrete placement, determine locations to avoid being near steel and select areas where approximately a 3" to 4" depth is available when possible. Mark reference points for locations where nuclear densities are to be obtained.

2. Immediately behind the finishing machine, but prior to texturing and curing operations, place the nuclear gauge on the plastic concrete surface at the predetermined location as follows:

   Position the gauge on the concrete surface and extend the direct transmission probe of the nuclear gauge to the 2-inch test position. It is extremely important that the gauge be pulled slightly toward the scaler end so that the probe is in direct contact with the concrete. Any void between the probe and the concrete could cause an erroneous reading.

   NOTE - Use guide plate and steel rod furnished with the gauge when excessive pressure is required to extend the nuclear probe into the concrete overlay.

3. Take and record a one-minute density count.

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4. Before removing the nuclear apparatus from the concrete the probe should be inside the gauge. The brass wiping ring at the base of the gauge should be periodically checked to insure that concrete particles will not get inside the gauge when retracting probe.

   NOTE - A light coat of oil and graphite on the probe, lead shield and gauge case should be used to prevent Portland Cement Concrete from adhering.

5. Using a probe and ruler, determine the depth of resurfacing at the in-place test location.

6. Use the in-place density count, the average standard density count and the calibration curves or tables to determine the nuclear density of the concrete.

7. Using the theoretical concrete unit weight as a base, calculate percent consolidation as follows: The theoretical unit weight can be obtained from the Regional Materials Engineer.

$$\% \text{ Consolidation} = \frac{\text{In-Place Nuclear Density}}{\text{Theoretical Unit Weight}} \times 100$$

Rounding: 97.5 is rounded up to 98%

TESTING FREQUENCY

One density reading should be taken per twelve (12) foot lane width and every 20 to 30 linear feet of overlay placed. Locations should be selected randomly across the width of overlay.

If a failing test is obtained check for gauge seating in the concrete. Take one additional test, if this also fails re-vibrate and re-test for density.

DOCUMENTATION

Record all density data on the High Density Concrete Project Testing Report shown in Appendix C.

APPENDIX A

DENSITY GAUGE QUALIFICATION

Gauge qualification is required every 30 days or whenever density readings are suspect. This qualification checks both the stability and drift of the gauge.

This method has been taken from the Troxler instruction manual for both the 2400 and 3400 series gauges and consists of the following:

A. Instrument Stability Test

1. Follow warm-up procedures for gauge.
2. Take and record 20 one-minute standard density counts.
3. Calculate the predicted deviation by obtaining the square root of the average value for the 20 one-minute counts.
4. Calculate the actual deviation of the 20 one-minute counts by the root mean square statistical method.
5. Calculate ratio of deviations. Actual deviation divided by predicted deviation. (Step 4 ÷ Step 3.)
6. Determine if calculated ratio meets the limits set by Troxler for the particular type gauge.

Troxler Gauge	Acceptable Limits
3400	0.18 to 0.35
2400	0.8 to 1.25

NOTE - For other gauge manufacturers consult the owners manual.

B. Instrument Drift Test

After the instrument has been in operation for 4 to 6 hours, 5 additional one-minute standard counts should be taken in the slow (4 min.) time function and averaged.

The drift of the instrument can now be calculated by subtracting from the original mean standard count (OMS), the mean standard count taken 4 to 6 hours later (FMS) and dividing this difference by the average of the two mean standard counts and multiplying by 100.

$$\text{Instrument drift} = \frac{\frac{OMS - FMS}{OMS + FMS}}{2} \times 100$$

This drift should not be greater than 0.5%.

Attached is a completed example for both the stability and drift tests for a Troxler 3400 series gauge. The method is identical for the Troxler 2400 series gauge. However, the acceptable range for the ratio of actual to predicted standard deviation is different.

APPENDIX A (cont.)

STATISTICAL TEST DATA
(Troxler 3400 Series)

STABILITY TEST

X	$X-\overline{X}$	$(X-\overline{X})^2$
2400	6.9	47.61
2379	-14.1	198.81
2379	-14.1	198.81
2410	16.9	285.61
2412	18.9	357.21
2388	- 5.1	26.01
2376	-17.1	292.41
2387	- 6.1	37.21
2410	16.9	285.61
2394	.9	.81
2402	8.9	79.21
2390	- 3.1	9.61
2391	- 2.1	4.41
2392	- .1	.01
2371	-22.1	488.41
2401	7.9	62.41
2402	8.9	79.21
2375	-18.1	327.61
2395	1.9	3.61
2407	13.9	193.21

$T_1 = 47861$ $T_2 + 2977.80$

$$OMS = \overline{X} = \frac{T_1}{N} = \frac{47,861}{20} = 2393.1$$

$$S_{Theoretical} = \overline{X}^{\frac{1}{2}} = (2393.1)^{\frac{1}{2}} = 48.92$$

$$S_{Sample} = \left(\frac{T_2}{N-1}\right)^{\frac{1}{2}} = \left(\frac{2977.80}{19}\right)^{\frac{1}{2}} = 12.52$$

$$Ratio = \frac{S_{Sample}}{S_{Theoretical}} = \frac{12.52}{48.92} = 0.26^*$$

*Gauge Stability is ok since the ratio of 0.26 is between limits set by Troxler of 3400 Series Gauge of 0.18 to 0.35.

DEFINITIONS:

X = one minute standard density count.

$\overline{X}$ = average of N one minute standard density counts.

T_1 = total of N one minute standard density counts. In this case N = 20.

T_2 = total of N differences from the mean count.

T_3 = total of 5 slow 4 minute time function standard density counts.

N = number of standard density tests run.

S = Standard Deviation

OMS = original mean standard count ($T_1 \div 20$)

FMS = final mean standard count ($T_3 \div 5$)

DRIFT TEST (Slow 4 minute time function)

2392
2390
2397
2384
2393

$T_3 = 11956$

$$FMS = \frac{T_3}{N} = \frac{11956}{5} = 2391.2$$

$$\text{Instrument Drift} = \frac{OMS - FMS}{\frac{(OMS + FMS)}{2}} \times 100$$

$$\text{Instrument Drift} = \frac{2393.1 - 2391.2}{(2393.1 + 2391.2)} \times 100$$

Instrument Drift = 0.08% < 0.5% ∴ Gauge OK

APPENDIX B

DAILY STANDARD COUNT (ON SITE CHECK)

The standard count should be checked a minimum of 3 times a day, prior to initial placement, midday and at the end of day after placement.

The calibration of this instrument is made in terms of a ratio to a count made on a Reference Standard which is supplied with the instrument. For this reason, measurements made with the instrument can be no more accurate than the accuracy of the reference counts. The operator should therefore use care to establish a set of reference counts for density. A log should be kept of these counts throughout the life of the instrument since this will establish a norm for the rate of change per unit time and allow the user to determine when a defect may be occurring either in the procedure or the instrument.

If the day-to-day shift in standard count is greater than 1% for density, there is a possibility of a gauge malfunction or operator error in placing the gauge on the standard. Since the radiation statistics may on occasion cause this degree of shift, a second attempt to acquire usable standard counts is permissible. If, over a long period of time (several months), the shift in standard count exceeds 3% for density, the gauge calibration should be checked. For this reason, a log should be kept of the gauge standard counts. The initial standard counts will normally be less than the factory standard counts due to the higher background radiation levels in the factory.

The Reference Standard should be placed on a dry, flat surface well away from any building or other large structure and not closer than thirty feet to another nuclear gauge. The surface can be asphalt or concrete paving, compacted aggregate or similar material containing not more than 15 PCF moisture. Sites not to be used are truck beds or tailgates, table tops or similar structures of low mass.

Switch the gauge power ON and position the instrument on the Reference Standard according to manufacturer's instruction. Make certain that the standard is clean and does not have soil or other material in the seating area which would prevent good surface contact with the gauge base.

Remove the lock from the trigger and make certain that the handle is indexed in the standard or safe position. Do not proceed unless gauge power has been on for at least 15 minutes. This time is to allow stabilization of the regulators and detectors.

Take and record the average of 4-one-minute standard counts.

If the counts deviate more than the values previously stated from prior standard counts, check for gauge seating and positioning before taking another set.

If an instability is suspected, the gauge should have a complete stability check run as explained in Appendix A - Density Gauge Qualification.

BR 23 (6/79)

HIGH DENSITY CONCRETE
PROJECT TESTING REPORT

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

CONTRACT: D95646
DATE : 6-7-79
PREPARED BY: J. Bushey

NUCLEAR GAUGE INFO.
GAUGE SERIAL NO. 3141
STD. BLOCK SERIAL NO. 3141

SLUMP, AIR, & CYLINDER TESTING						
1. Time of Test	AM 8:05	AM 8:30	AM 9:00	AM 9:24	AM 10:05	AM 10:30
2. Slump (inches)	1/2"	3/4"	1/2"	1/2"	1/4"	3/4"
3. Air Content (%)	5.4%	6.2%	6.1%	5.9%	5.7%	6.4%
4. Mixing Unit I.D.#	5432	4350	5432	4350	5432	4350
5. Air Entrainer - Flowmeter Setting	3.0	2.4	3.4	2.4	3.4	2.4
6. Water Flowmeter Setting	7.2	7.4	7.2	7.4	7.0	7.4
7. Cylinder Numbers (if applicable)	1M 1N	2M 2N	—	—	—	—
IN-PLACE DENSITY DETERMINATION	← SPAN 1 →					
8. Time of Test	AM 8:30	AM 8:30	AM 9:15	AM 10:20		
9. Test Location	0+57 7' R.C.	0+73 2' R.C.	0+130 10' R.C.	0+158 5' R.C.		
10. Depth of Test Location	2 1/2"	2 3/4"	3 1/2"	4"		
11. Gauge Standard Count	255	255	255	255		
12. In-Place Gauge Density Count	690	692	679	702		
13. Count Ratio = (#12 ÷ #11)	2.706	2.714	2.663	2.753		
14. In-Place Density (Table)	144.5	144.5	146.0	143.0		
15. Project Concrete Theoretical Unit Wt. = 143.8						
16. % Consolidation = $\frac{\text{In-Place Density (\#14)}}{\text{Theo. Unit Wt. (\#15)}} \times 100$	100.5	100.5	101.5	99.4		

REMARKS: Test Location: R.C. is Right Curb Offset.

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